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DIRECT SOWING IMPROVES CHLOROPHYLL CONTENT OF SILAGE MAIZE FULLY IRRIGATED WITH RECYCLED WASTE WATER BY INCREASING WATER RETENTION IN THE SOIL

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Abstract
Increasing fresh water shortage has revealed the use of waste water in agricultural irrigation, deficit irrigation approaches and integrated management of soil moisture with tillage-sowing practices. The crop productivity in the irrigated conditions is directly controlled by photosynthetic activities. Therefore, the effects of the irrigation with recycled domestic waste water at different irrigation water levels (100%, 67% and 33%), compared to full irrigated fresh water, on the chlorophyll content of silage maize and surface soil moisture in conventional tillage and direct sowing conditions were examined in the irrigation periods of two experimental years (2020 and 2021). The soil moisture was determined by 1.5% higher in direct sowing than in conventional tillage, and the chlorophyll content in full irrigation with waste water and the direct sowing was found by 4.9% and 1.9% higher than in full irrigation with fresh water and conventional tillage, respectively. However, chlorophyll content decreased by 20.7% and 34.0% at 33% and 67% deficit irrigation with waste water compared to full irrigation with waste water. The significant ($p<0.01$) linear correlation between the soil moisture and chlorophyll content showed that chlorophyll content can be managed with the soil moisture. It can have concluded that full irrigation with waste water in the direct sowing can be recommended with positive effects on the conservation of fresh water resources, effective managing soil moisture, thus saving irrigation water, increasing chlorophyll content and crop productivity.

Keywords: Chlorophyll content, conventional tillage, direct sowing, irrigation water levels, soil moisture, waste water

1. INTRODUCTION

The water supply crisis, which has emerged as one of the biggest problems of today (World Economic Forum, 2015), has revealed the necessity of using waste water for irrigation in the agricultural sector, where water is consumed the most. Waste water can be defined as water that has been physically, chemically and biologically polluted with different uses, and content has changed according to time, space and discharge. Although waste water is thought to be a polluted water source at first glance, considering that most of it is composed of only water, waste water should not be evaluated as a polluted water source (UN, 2014). The biggest criterion that distinguishes waste water from other waters is its rich organic matter and nutrient content (Rivas et al., 2017). Thus, waste water, which reduces the need for synthetic fertilizer, develops to the economy and environmental sustainability via its disposal, as well as keeping fresh water resources clean and relieving the pressure on them.

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One of the effective ways of using water in agriculture is deficit irrigation practices. Especially in arid and semi arid regions with insufficient water resources, effective management of water resources is ensured by providing a portion of the water needed by the crop instead of all. In addition, minimum soil tillage or direct sowing practices that reduce the amount of irrigation water by preserving the soil moisture for a longer time also help effective water use. Researchers reported that the amount of irrigation water decreased and the soil moisture retention increased with the decrease of evaporation due to the crop-residues left in the soil covering the soil surface in direct sowing according to conventional tillage (Qi et al., 2018). In addition, direct sowing increases soil organic matter and reduces fertilizer input, thus making positive contributions to crop yield (Mousavi-Boogar et al., 2021).

The yield and quality of the crop is directly governed by photosynthetic activities (Kacar et al., 2013). As a result of photosynthesis, cells containing chlorophyll assimilate carbon dioxide and water to form carbohydrates (Demirtas and Kirnak, 2009). The presence of nutrients and water in the soil, abiotic and biotic stress conditions, air temperature and other weather conditions directly affect the chlorophyll content. Previous studies showed that waste water irrigated silage maize are limited to evaluating the effects on only harvest chlorophyll content or taking few measurements. Therefore, in this study carried out under conventional and direct tillage-sowing applications, the effect of the applying of recycled domestic waste water at different irrigation levels by drip irrigation on chlorophyll content of silage maize and soil moisture, and their relationship were investigated throughout two irrigation periods.

2. MATERIALS AND METHODS

The study was carried out in the experimental area of the Faculty of Agriculture, Van Yuzuncu Yil University with an altitude of 1670 m, which has a semi-arid climate, during the vegetation period including from May to September in 2020 and 2021.

According to the data in climate station (Imetos 2) located in the study area, the precipitation and temperature values in the vegetation period of silage maize of 2020 and 2021 were 37.0 mm, 22.4°C and 52.1 mm, 22.8°C, respectively.

Mean values of soil properties prior to the experiment in 90 cm soil layer as three layers of 30 cm showed that, soil texture was sandy-clay-loam, and bulk density, porosity, aggregate stability, EC, pH, $CaCO_3$, total N, P_2O_5 and K_2O changed between 1.31-1.40 g cm^{-3}, 48.0-51.8%, 43.8-44.8%, 0.335-0.390 dS m^{-1}, 8.17-8.50, 10.7-15.2%, 0.079-0.081%, 78-89 kg ha^{-1} and 880-909 kg ha^{-1}, respectively.

While the tap water of Van Yuzuncu Yil University was used as the fresh water source, the domestic treated waste water was provided from biological waste water treatment plant located in the Edremit district of Van province, Turkey. According to the mean values during the irrigation periods in experiment years, EC, pH and SAR values of fresh water were 0.353 dS m^{-1}, 8.15 and 0.82, respectively, while EC, pH, SAR, total N, biological and chemical oxygen demands of recycled waste water were 1.124 dS m^{-1}, 7.58, 2.53, 10.9 mg l^{-1}, 23.2 mg l^{-1} ve 37.5 mg l^{-1}, respectively.

Irrigation waters were applied by surface-drip irrigation with drip lines located for each crop row. The dripplines with emitter flow of 2.3 l h^{-1} in spacing of 33 cm were operated at a pressure of 0.1 MPa which provided by a centrifugal pump. Applied water was measured by water meters placed at the entrance of each plot.

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In the study, which was carried out in a randomized block design with a split-plot desing, three replications were made, the main treatments were conventional tillage (CT) and direct sowing (DS), sub treatments were full irrigation with fresh water (FW100), full irrigation with waste water (WW100), 33% deficit irrigation with waste water (WW67) and 67% deficit irrigation with waste water (WW33). The total number of plots in the experimental area was 24, and each plot was arranged with 5 rows and crop spacing as 70 cm × 15 cm (3.5 m × 7.2 m = 25.2 m^2).
Soil was firstly ploughed in CT treatment, and then used cultivator-rotary harrow, and finally seeds of silage maize (cv: OSSK-644) were sown with a pneumatic seeder. In DS treatment, sowing was same day as CT without soil tillage with a direct-sowing machine. For weed control in CT treatment, the first hoeing was done when the crop height was 15-20 cm, the second hoeing was in the form of throat filling when the crop height was 40-50 cm. Herbicide was applied in DS to destroy weeds.
In the first study year, 100 kg ha^{-1} urea and 150 kg ha^{-1} superphosphate fertilization was used to all-plots at the time of sowing, and in the throat filling stage, a second urea fertilization was made equal to the first dose also (Celebi et al. 2010). In the second study year, fertilization was carried out only in fresh water plots. The missing quantities were completed considering the total N and P_2O_5 analyzes made in the soil tillage-sowing treatments.
All plots until the crop height reached 40-50 cm were fresh water irrigated with a 30% wetting percentage considering moisture content deficit at 30 cm depth in the fresh water plots according to field capacity. The irrigations in this period was done when the Σ (ET_c – precipitation) amount reached 40% of the available water at 30 cm depth (≈19 mm). In the next stage, in chlorophyll content measurement period, deficit irrigation treatments with waste water were started and at this stage, totally 9 and 8 irrigations applied in 2020 and 2021 years. The irrigations were carried out with 65% wetting percentage consireing moisture deficits at 90 cm depth in the fresh water plots of each soil tillage-sowing treatment. In this period, irrigations was done when the Σ (ET_c – precipitation) amount reached 40% of the available water at 90 cm depth (≈60 mm). ET_c was calculated with the equation $ET_c = ET_o \times k_c$ (Allen et al. 1998). While ET_o values were determined using CROPWAT program, k_c values were obtained from a guide (TAGEM 2017). The climate data required for ET_o calculations and precipitation values were taken from the Imetos 2 - climate station located in the experimental area. In 2020, 351-319 mm, 242-220 mm and 129-118 mm irrigation quantities were applied for 100%, 67% and 33% irrigation levels in CT and DS treatments, respectively, while in 2021, 327-294 mm, 226-204 mm and 122-111 mm were applied, respectively.
Soil moisture probe (Trime-Pico, IMKO) calibrated in the experiment soil, was used for soil moisture measurements in surface soil simultaneously with chlorophyll content measurements. The soil moisture measurements were made at 10 cm and 20 cm soil depths in all plots and averaged. Chlorophyll content measurements mid time of two irrigations (ET_c - precipitation = ≈ 30 mm) to determine the changing shade of green depending on the chlorophyll content in the middle leaves of three randomly selected crops from each plot, using the SPAD-502 chlorophyll meter device (Konica Minolta Sensing, Inc., Japan), was made between 10-00 and 14:00 hours. The measurement for chlorophyll content and soil moisture were made at the harvest also.
Data analyzes were made using the variance analysis (ANOVA) with the SPSS package program, and Duncan multiple comparison test was performed for the means found to be significant. In addition, Pearson correlation analysis was also used for correlation relations.

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3. RESULTS AND DISCUSSIONS

The soil moisture contents for treatments throughout the irrigation periods in the first and second experimental years were given in Figure 1. The effect of each irrigation treatment on soil moisture was determined significant at $P<0.01$ and $P<0.05$ levels in both years of the experiment (except 4. irrigation in the first year and 8. irrigation in the second year), while the effect of soil tillage-sowing treatments on soil moisture was not significant (except 8. irrigation in the first year) (Table 1). However, considered the mean values of 2020, 2021 and 2020-2021, the significant effects of both irrigation and soil tillage-sowing treatments on soil moisture were determined (Table 1). In the mean of all years, the similar soil moisture values were obtained in WW100 and FW100, while the value in WW100 treatment was 1.8% and 3.5% higher than in WW67 and WW33, respectively. The soil moisture was found by 1.5% higher in DS than CT also (Figure 2).

While the decrease in soil moisture due to increased irrigation water deficit can be associated with decreased irrigation quantity, the higher soil moisture values in DS can be evaluated due to the effect crop residue left in the soil surface decreses evaporation. Many studies have been reported that the soil moisture increased and the amount of irrigation water decreased in DS compared to intensive tillage practices (Qi et al., 2018; Gozubuyuk et al., 2020; Burke et al., 2021). In addition, considering that soil tillage-sowing practices significantly affect soil porosity (Barut et al., 2010), it is possible to appear different water loss from soil depending on pore size distribution and connectivity. Kucukalbay and Akbolat (2015) stated that the lowest porosity values were obtained in DS among different tillage treatments. Ghosh et al. (2020) similarly reported that there was lower porosity in DS compared to CT and that conservative tillage increased the micropores that allow water retention in the soil.

The chlorophyll content for treatments throughout the irrigation periods in the first and second experimental years were given in Figure 3. The effect of each irrigation treatment on chlorophyll content was determined significant at $P<0.01$ level in both years of the experiment, while the effect of soil tillage-sowing treatments on chlorophyll content was significant at $P<0.01$ and $P<0.05$ levels only in the 1. and 2. irrigations in 2020 and in the 5. irrigation in 2021 (Table 2). However, considered the mean values of 2020, 2021 and 2020-2021, the significant effects of both irrigation and soil tillage-sowing treatments on chlorophyll content were determined (Table 2). In the mean of all years, 4.9%, 26.1% and 51.5% higher chlorophyll content values were obtained in WW100 compared to FW100, WW67 and WW33, respectively, while chlorophyll content was 1.9% higher in DS than CT (Figure 4).

Recycled waste water was including 0.42 Fe and 10.9 mg l^{-1} total N contents as the mean of two experimental years. The higher chlorophyll content in WW100 can be explained by the Fe contribution of the waste water. Abdel Latef and Sallam (2015) reported that the increase in chlorophyll content in irrigation with waste water is due to the increase in the rate of chlorophyll biosynthesis. In this case, the association of higher chlorophyll content values with the Fe content of waste water can be considered in waste water irrigations (Rout and Sahoo, 2015). Fe is an important nutrient in both chloroplast formation and protein development (Yerli et al., 2020). In addition, N, which is a part of chlorophyll, is one of the important factors supporting the increase in chlorophyll in leaves. In the case of N deficiency, the chlorophyll concentration in the leaves decreases. The N content of waste water can be seen as one of the important factors supporting the increase of chlorophyll in leaves (Liu et al., 2018). Since maize, a C4 crop, has more photosynthetic activity compared to other crops, it can metabolize high levels of N from waste water (Alkhamisi et al., 2011).

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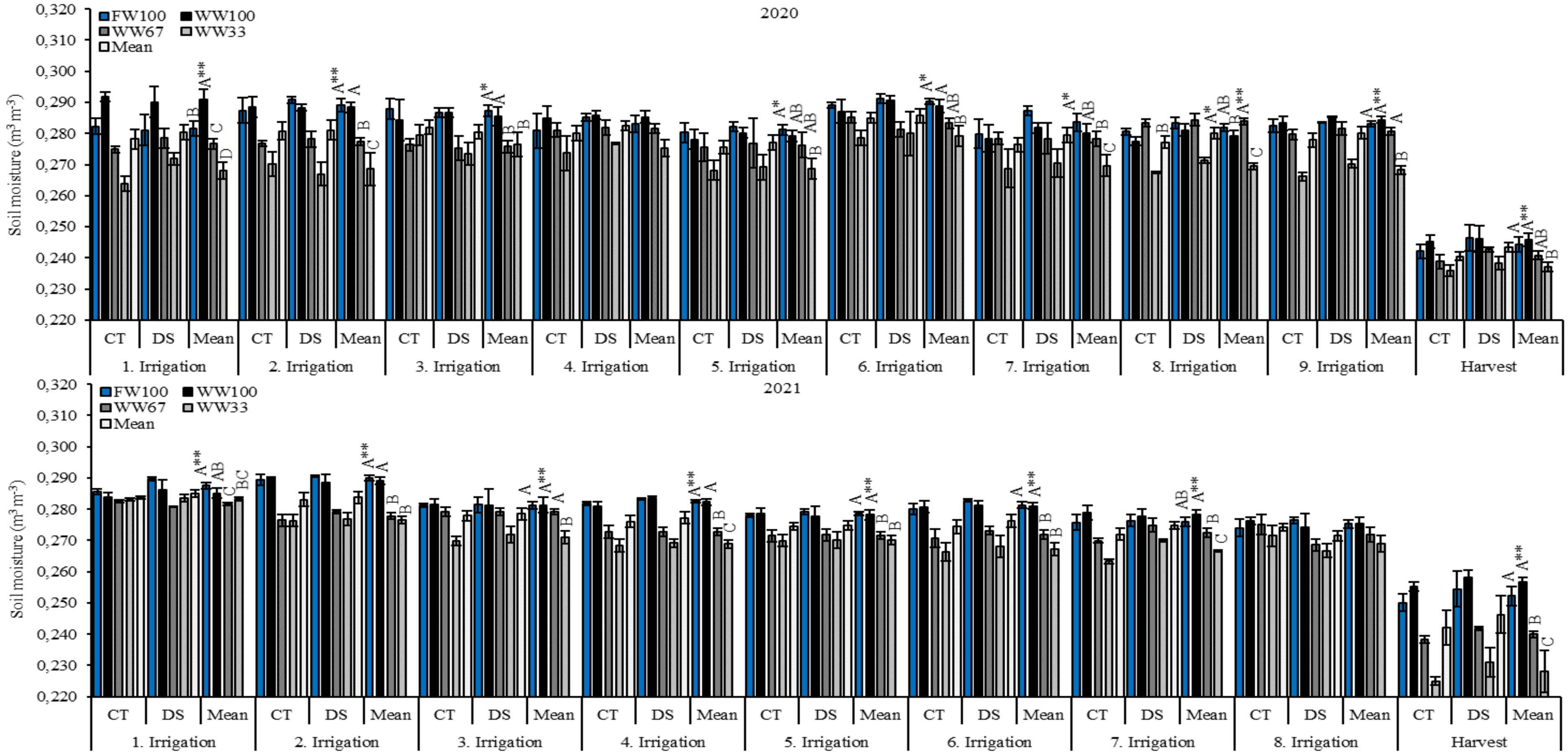

Figure 1. The soil moisture in treatments throughout the irrigation periods in 2020 and 2021 years. CT: Conventional tillage, DS: Direct sowing, FW100: full irrigation with fresh water, WW100: full irrigation with waste water, WW67: 33% deficit irrigation with waste water, WW33: 67% deficit irrigation with waste water
*****: P<0.01, *: P<0.05***

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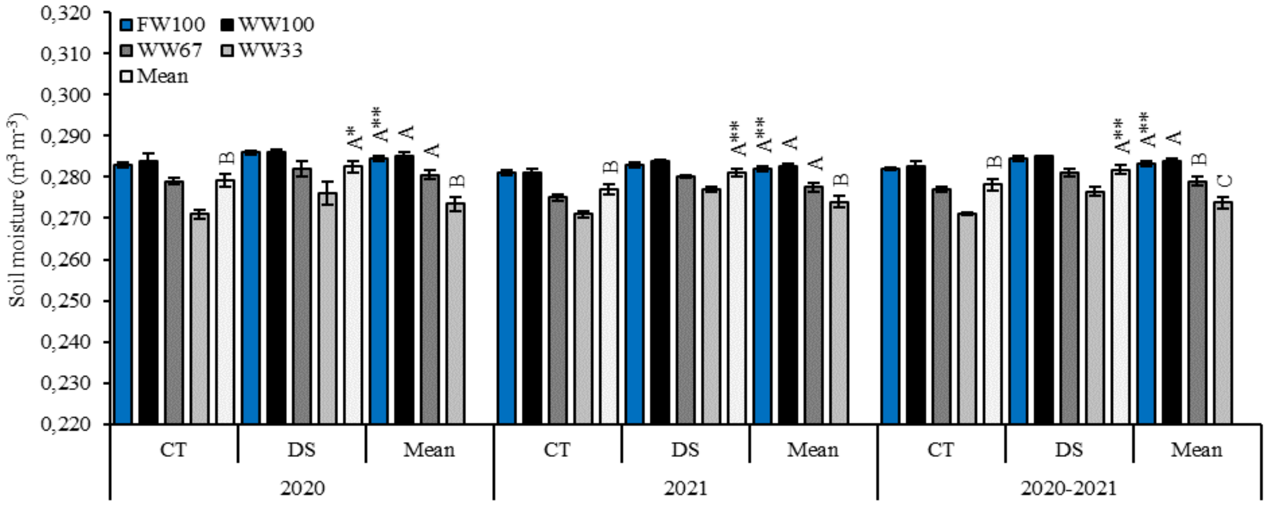

Figure 2. The mean soil moistures in the treatments in 2020, 2021 and 2020-2021 years. CT: Conventional tillage, DS: Direct sowing, FW100: full irrigation with fresh water, WW100: full irrigation with waste water, WW67: 33% deficit irrigation with waste water, WW33: 67% deficit irrigation with waste water **: P<0.01, *: P<0.05

As a result of different studies, it has been reported that irrigation with waste water increases the chlorophyll content (Petousi et al., 2015; Alkhamisi et al., 2017; Petousi et al., 2019; Cakmakci and Sahin, 2021; Soltani-Gerdefaramarzi et al., 2021).

The decrease in chlorophyll content due to increased water stress can be explained by insufficient soil moisture limiting the uptake of N which improved chlorophyll. The increase in chlorophyll content with increasing the soil moisture was also supported by a strong (P<0.01) positive correlation relationship between the soil moisture and chlorophyll content (Figure 5). In addition, it is possible that the crop loses its turgor with water stress and the leaf cells pass through the plasmolysis state, the cell membrane systems are damaged, and the chlorophyll content is decreased due to the deterioration of chlorophyll function. Anjum et al. (2011) reported that the chlorophyll content decreased as a result of the arrest of cell division or expansion under drought stress conditions. Bauerle et al. (2004) stated that chlorophyll content is a clear indicator of crop water stress. In addition, an increase in leaf temperature under water stress conditions causes a decrease in chlorophyll content (Ors and Ekinci, 2015). Carroll et al. (2017) stated that drought managed crops had lower chlorophyll content than crops managed with full irrigation. Many studies have been reported that deficit irrigation reduces the chlorophyll content (Camoglu et al., 2011; Soureshjani et al., 2019; Cakmakci and Sahin, 2021).

The higher chlorophyll content in DS compared to CT may be related to the higher soil moisture due to crop residue management in DS (Figures 1 and 2) and the N contribution of crop residues to the soil. The results of this study showed that the total N content of the surface soil increased by 7.8% in DS treatment compared to the CT. Gozubuyuk et al. (2020) repoted that in DS, soil moisture is better managed than other tillage practices. Malhi et al. (2018) stated that minimum tillage adds N to the soil, while intensive tillage increases the rate of decomposition of N, causing a decrease in the N content of the soil. János (2010) pointed out that soil N content and chlorophyll content were highly correlated, and Liu and Wiatrak (2011) pointed out that N fertilization in maize increased chlorophyll content in DS. It has been reported that the chlorophyll content is increased in DS compared to CT in previous studies (Chen et al., 2007; Kulig et al., 2010; Kumari et al., 2021).

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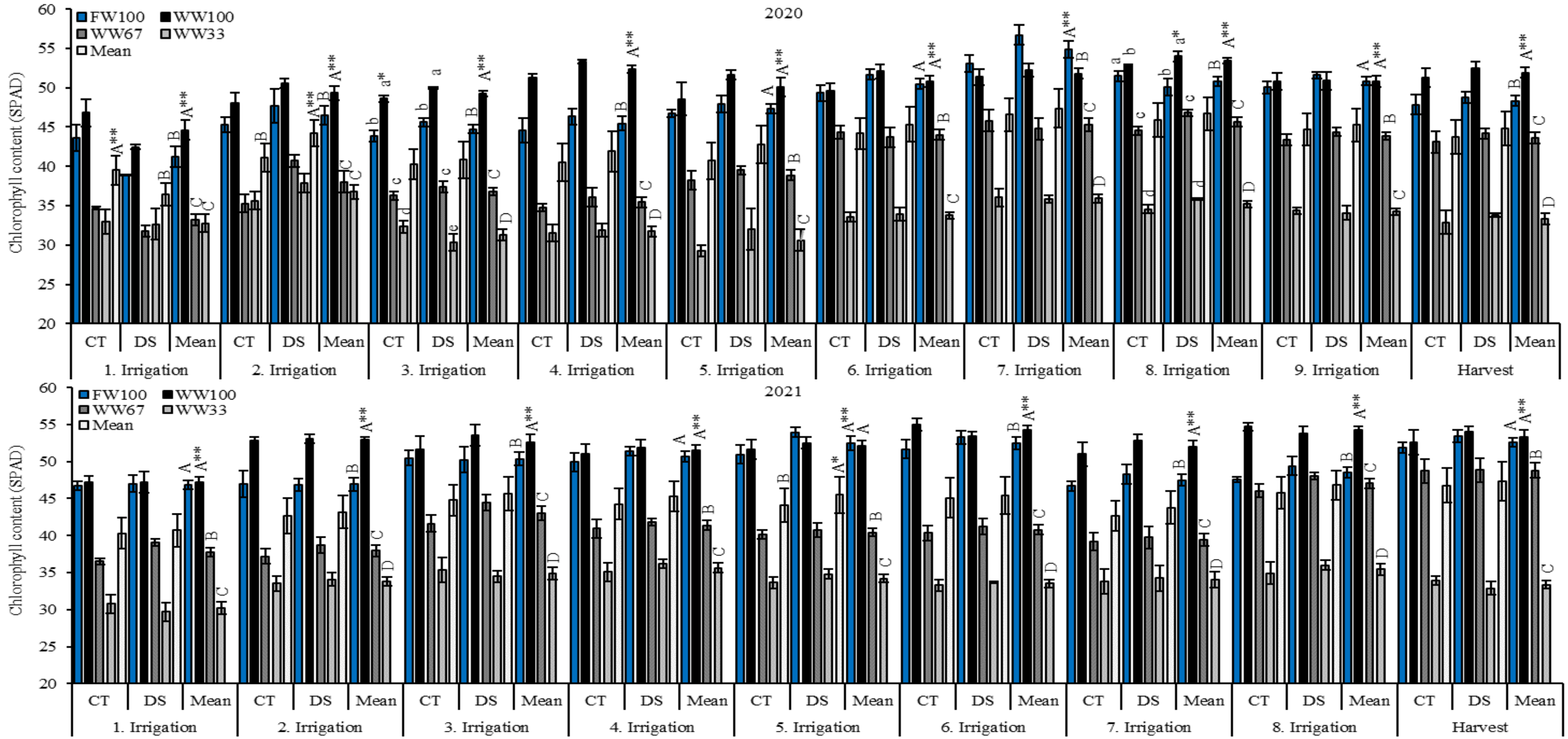

Figure 3. The chlorophyll contents in treatments throughout the irrigation periods in 2020 and 2021 years. CT: Conventional tillage, DS: Direct sowing, FW100: full irrigation with fresh water, WW100: full irrigation with waste water, WW67: 33% deficit irrigation with waste water, WW33: 67% deficit irrigation with waste water
*****: P<0.01, *: P<0.05***

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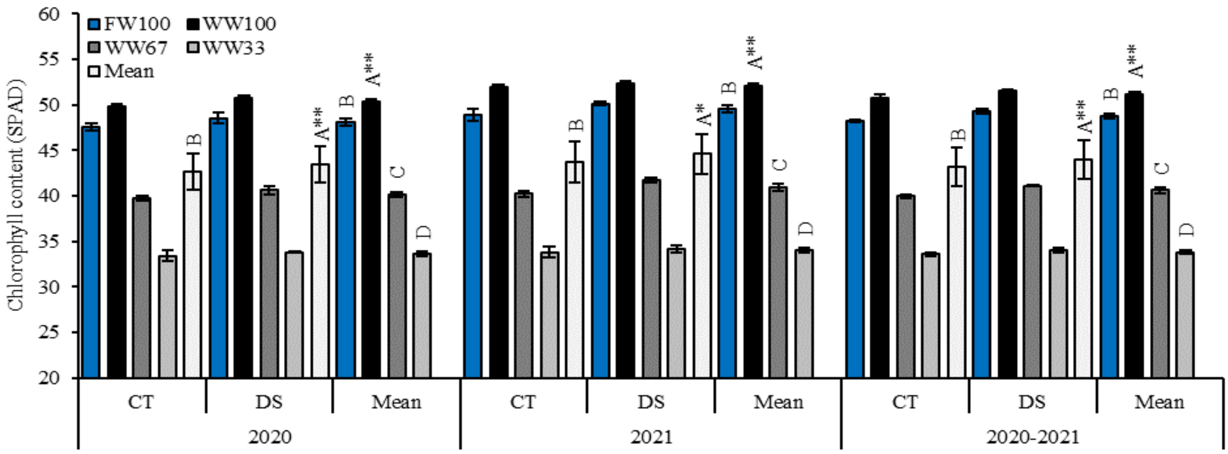

Figure 4. The mean chlorophyll contents in the treatments in 2020, 2021 and 2020-2021 years. CT: Conventional tillage, DS: Direct sowing, FW100: full irrigation with fresh water, WW100: full irrigation with waste water, WW67: 33% deficit irrigation with waste water, WW33: 67% deficit irrigation with waste water, **: P<0.01, *: P<0.05

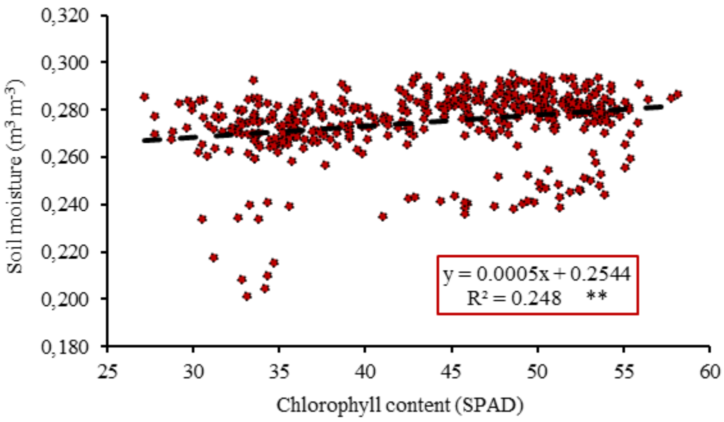

Figure 5. The relationship of the chlorophyll content with the soil moisture content **: p<0.01

4. CONCLUSIONS

In this study, in which the effects of the applying of treated domestic waste water at different irrigation levels under different tillage practices on the soil moisture and chlorophyll content of silage maize and their relationship, it was determined that the soil moisture was by 1.5% higher in DS than in CT treatment thus it is possible to save irrigation water in direct sowing, and the effect of irrigation treatments on chlorophyll content in all irrigations was determined significant but the effect of tillage-sowing treatments was limited. Considering the mean of all years also, the effect of irrigation and tillage-sowing treatments on the chlorophyll content was significant. The chlorophyll content decreased by 20.7% and 34.0% with increasing water stress in WW67 and WW33 treatments compared to WW100. The increase in chlorophyll content with increasing soil moisture and the strong correlation between them showed that chlorophyll content can be managed with soil moisture. While chlorophyll content increased by 4.9% in WW100 compared to FW100, chlorophyll content was 1.9% higher in DS than CT. It could be concluded that full irrigation with waste water under DS condition can be recommendable due to its contribution to the chlorophyll content. However, the practice can be more improved with agronomic approaches special to the waste waters of different regions.

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Table 1. The variance analysis results for the soil moisture in each irrigation throughout the irrigation periods, and for means of irrigation periods of 2020, 2021 and 2020-2021 of the experiment

Source	df	Mean square	F	P	Mean square	F	P	Mean square	F	P
		2020 - 1. Irrigation			2020 - 2. Irrigation			2020 - 3. Irrigation		
Tillage	1	3.504E-005	1.599	0.224	6.667E-007	0.017	0.897	9.375E-006	0.225	0.642
Irrigation	3	0.001	25.203	0.000	0.001	15.090	0.000	0.000	4.972	0.013
Tillage × Irrigation	3	3.138E-005	1.432	0.270	1.156E-005	0.299	0.825	1.749E-005	0.420	0.741
Error	16	2.192E-005			3.863E-005			4.167E-005		
		2020 - 4. Irrigation			2020 - 5. Irrigation			2020 - 6. Irrigation		
Tillage	1	3.267E-005	0.701	0.415	6.667E-007	0.010	0.923	2.667E-006	0.089	0.769
Irrigation	3	0.000	2.439	0.102	0.000	3.767	0.032	0.000	5.060	0.012
Tillage × Irrigation	3	3.667E-006	0.079	0.971	1.678E-005	0.424	0.865	1.389E-005	0.465	0.711
Error	16	4.658E--05			6.921E-005			2.988-005		
		2020 - 7. Irrigation			2020 - 8. Irrigation			2020 - 9. Irrigation		
Tillage	1	5.704E-005	1.136	0.302	4.267E-005	8.463	0.010	3.267E-005	3.664	0.074
Irrigation	3	0.000	4.168	0.023	0.000	50.424	0.000	0.000	36.523	0.000
Tillage × Irrigation	3	1.482E-005	0.295	0.828	3.111E-006	0.617	0.614	2.333E-006	0.262	0.852
Error	16	5.021E-005			5.042E-006			8.917E-006		
		2020 - Harvest			2021 - 1. Irrigation			2021 - 2. Irrigation		
Tillage	1	2.400E-005	1.263	0.278	9.375E-006	1.642	0.218	3.375E-006	0.358	0.558
Irrigation	3	0.000	5.623	0.008	4.271E-005	7.482	0.002	0.000	33.881	0.000
Tillage × Irrigation	3	2.444E-006	0.129	0.942	1.104E-006	1.934	0.165	3.486E-006	0.370	0.776
Error	16	1.900E-005			5.708E-006			9.417E-006		
		2021 - 3. Irrigation			2021 - 4. Irrigation			2021 - 5. Irrigation		
Tillage	1	2.042E-006	0.118	0.736	7.042E-006	1.112	0.307	1.667E-007	0.017	0.898
Irrigation	3	0.000	8.941	0.001	0.000	44.708	0.000	0.000	12.734	0.000
Tillage × Irrigation	3	2.153E-006	0.124	0.944	2.375E-006	0.375	0.772	7.222E-007	0.073	0.973
Error	16	1.729E-005			6.333E-006			9.833E-006		
		2021 - 6. Irrigation			2021 - 7. Irrigation			2021 - 8. Irrigation		
Tillage	1	2.204E-005	1.482	0.241	5.104E-005	4.224	0.057	4.267E-005	2.322	0.147
Irrigation	3	0.000	19.506	0.000	0.000	13.045	0.000	5.383E-005	2.930	0.065
Tillage × Irrigation	3	1.486E-006	0.100	0.959	2.026E-005	1.677	0.212	2.389E-005	1.300	0.309
Error	16	1.488E-005			1.208E-005			1.838E-005		
		2021 - Harvest								
Tillage	1	5.704E-005	1.740	0.206						
Irrigation	3	0.003	82.922	0.000						
Tillage × Irrigation	3	3.486E-006	0.106	0.955						
Error	16	3.279E-005								
		2020 - Mean			2021 - Mean			2020-2021 - Mean		
Tillage	1	0.000	5.000	0.040	6.667E-005	16.000	0.001	7.660E-005	43.637	0.000
Irrigation	3	0.000	10.333	0.001	3.333E-005	8.000	0.002	0.000	75.879	0.000
Tillage × Irrigation	3	4.167E-006	0.200	0.895	3.333E-005	8.000	0.002	3.161E-006	1.801	0.188
Error	16	2.083E-005			4.167E-006			1.755E-006		

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Table 2. The variance analysis results for the chlorophyll content in each irrigation throughout the irrigation periods, and for means of irrigation periods of 2020, 2021 and 2020-2021 of the experiment

Source	df	Mean square	F	P	Mean square	F	P	Mean square	F	P
		2020 - 1. Irrigation			2020 - 2. Irrigation			2020 - 3. Irrigation		
Tillage	1	56.734	11.872	0.003	58.907	12.830	0.002	1.760	1.328	0.266
Irrigation	3	209.308	43.800	0.000	230.697	50.247	0.000	386.262	291.335	0.000
Tillage × Irrigation	3	6.064	1.269	0.319	3.541	0.771	0.527	4.514	3.404	0.043
Error	16	4.779			4.591			1.326		
		2020 - 4. Irrigation			2020 - 5. Irrigation			2020 - 6. Irrigation		
Tillage	1	11.482	4.186	0.058	25.627	4.393	0.052	7.707	4.324	0.054
Irrigation	3	530.501	193.407	0.000	466.128	79.902	0.000	382.424	214.544	0.000
Tillage × Irrigation	3	0.769	0.281	0.839	1.474	0.253	0.858	3.498	1.962	0.160
Error	16	2.743			5.834			1.783		
		2020 - 7. Irrigation			2020 - 8. Irrigation			2020 - 9. Irrigation		
Tillage	1	4.084	1.138	0.302	3.840	3.654	0.074	1.984	1.031	0.325
Irrigation	3	422.152	117.618	0.000	390.101	371.230	0.000	370.746	192.679	0.000
Tillage × Irrigation	3	6.485	1.807	0.187	3.519	3.349	0.046	0.990	0.515	0.678
Error	16	3.589			1.051			1.924		
		2020 - Harvest			2021 - 1. Irrigation			2021 - 2. Irrigation		
Tillage	1	6.407	1.947	0.182	1.127	0.375	0.549	1.815	0.583	0.456
Irrigation	3	389.256	118.315	0.000	396.838	131.968	0.000	449.567	144.381	0.000
Tillage × Irrigation	3	0.034	0.010	0.998	3.363	1.118	0.371	0.814	0.261	0.852
Error	16	3.290			3.007			3.114		
		2021 - 3. Irrigation			2021 - 4. Irrigation			2021 - 5. Irrigation		
Tillage	1	4.770	0.839	0.373	6.827	2.157	0.161	11.760	4.521	0.049
Irrigation	3	384.619	67.650	0.000	349.572	110.464	0.000	485.799	186.756	0.000
Tillage × Irrigation	3	4.567	0.803	0.510	0.141	0.045	0.987	1.808	0.695	0.568
Error	16	5.685			3.165			2.601		
		2021 - 6. Irrigation			2021 - 7. Irrigation			2021 - 8. Irrigation		
Tillage	1	0.735	0.240	0.631	7.594	1.357	0.261	5.900	2.343	0.145
Irrigation	3	580.989	189.788	0.000	385.993	68.999	0.000	371.402	147.504	0.000
Tillage × Irrigation	3	2.898	0.947	0.441	0.770	0.138	0.936	2.725	1.082	0.385
Error	16	3.061			5.594			2.518		
		2021 - Harvest								
Tillage	1	1.602	0.394	0.539						
Irrigation	3	521.712	128.316	0.000						
Tillage × Irrigation	3	2.256	0.555	0.652						
Error	16	4.066								
		2020 - Mean			2021 - Mean			2020-2021 - Mean		
Tillage	1	3.920	9.978	0.006	4.250	8.260	0.011	4.167	27.778	0.000
Irrigation	3	351.537	894.686	0.000	410.246	797.239	0.000	379.696	2531.307	0.000
Tillage × Irrigation	3	0.066	0.168	0.916	0.465	0.903	0.461	0.150	1.000	0.418
Error	16	0.393			0.515			0.150		

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